

From the Southern Association for Vascular Surgery

Gender and 30-day outcome in patients undergoing endovascular aneurysm repair (EVAR): An analysis using the ACS NSQIP dataset

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Purpose: Prior studies have demonstrated higher in-hospital mortality in women undergoing open abdominal aortic aneurysm repair. The current study evaluates the relationship between gender and 30-day outcomes for endovascular aneurysm repair (EVAR) in a multicenter, contemporary patient population.

Methods: Patients in the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) participant use file that underwent EVAR of abdominal aortic aneurysm (AAA) from 2005 to 2007 were identified by CPT codes. Outcomes analyzed were 30-day mortality, morbidity (one or more of 21 complications defined by the ACS NSQIP protocol), length of hospital stay, and six complication subgroups. Preoperative risk factors, intraoperative variables, and outcomes were compared across genders using χ^2 (binary and categorical variables) and *t* tests (continuous variables). The relationship of gender to outcomes was further evaluated using multivariate logistic regressions to adjust for pre- and intraoperative risk variables.

Results: In 3662 EVAR patients, 647 (17.7%) were women and 3015 (82.3%) men with mean ages of 75.1 ± 9.0 and 73.7 ± 8.5 years ($P < .001$). Tube graft (360, 9.8%); bifurcated, one docking limb (1624, 44.3%); bifurcated, two docking limbs (1294, 35.3%); unibody (218, 5.9%); and aorto-uni-iliac/femoral (166, 4.4%) repairs were performed. Tube and aorto-uni-iliac/femoral grafts were more common in women (21.4% vs 12.8%, $P < .001$) than men, as were femoral/femoral crossovers (3.9% vs 1.8%, $P = .011$) and iliac or brachial exposures (2.8% vs 1.0%, $P = .009$). Overall morbidity and mortality were 11.9% and 2.1%, respectively. Mortality in women was significantly higher (3.4% vs 2.1%, $P = .014$), as was morbidity (17.8% vs 10.6%, $P < .001$). Of thirteen independent preoperative risk factors for mortality or morbidity, women had a higher incidence in five: emergent operation, functional dependence, recent weight loss, underweight status or morbid obesity, and severe chronic obstructive pulmonary disease (COPD). After adjustment for these variables, the odds ratio (OR) for mortality in women vs men was 1.52 (95% confidence interval [CI] 0.85-2.69, $P = .157$); OR for morbidity was 1.65 (95% CI 1.28-2.14, $P < .001$). Female gender was also found to be an independent risk factor for length of stay (Beta 0.7 days, 95% CI 0.2-1.2, $P = .006$), infectious complications (OR 1.49, 95% CI 1.10-2.03, $P = .011$), wound complications (OR 1.80, 95% CI 1.12-2.90, $P = .015$) and postoperative transfusion (OR 2.92, 95% CI 1.39-6.13, $P = .002$).

Conclusions: Mortality and morbidity were higher in women than men undergoing EVAR. Multivariate analysis showed that the increased risk of mortality was related to women presenting more emergently, more debilitated (recent weight loss and functional dependence), and requiring iliac or brachial exposure. After adjustment for multiple preoperative and operative factors, women remained at significantly higher risk for the development of a broad range of complications and increased length of stay. (*J Vasc Surg* 2009;50:486-91.)

Abdominal aortic aneurysms (AAA) account for 45,000 deaths per year in the United States with a 4:1 male to female predominance.¹ Despite having a less frequent prevalence, it has been suggested that women with AAA have a higher risk of rupture and significantly higher mortality and morbidity rates for both elective and emergent repair.^{2,3} With the introduction of endovascular devices, endovascular aneurysm repair (EVAR) has rapidly increased over the

past several years. Multiple reports such as the UK EVAR and Dutch Randomized Endovascular Aneurysm Management (DREAM) trials have demonstrated decreased 30-day mortality with the use of endovascular repair compared with open repair.^{4,5}

While several authors have included the influence of gender on outcomes following endovascular repair of AAA, the current literature suffers from inherent deficiencies. Because AAA is a disease primarily affecting men, studies to date often include a relatively small sample size of women. This is especially problematic with reports that come from a single institution. Reports of industry sponsored trials that are designed to demonstrate the efficacy of an endograft may have selection bias related to industry protocols; specifically exclusion criteria that may make it more difficult to enroll women due to difficult anatomic conditions. One difference related to gender often noted in these studies appears to be higher rates of access related complications

From the Department of Surgery, University of Kentucky College of Medicine.

Competition of interest: Dr Minion is a consultant and has received honoraria from W.L. Gore and Associates.

Additional material for this article may be found online at www.jvascsurg.org.

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and need for open conversion in women.^{6,7} Finally, early studies focused on comparisons between open and endovascular aneurysm repair and differences in outcome associated with gender were secondary observations.

The purpose of the current study was to test the hypothesis that gender influences 30-day outcomes for endovascular aneurysm repair. The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database was used to identify a large patient population undergoing EVAR from multiple and diverse medical centers in order to evaluate contemporary outcomes.

METHODS

Data from the ACS NSQIP participant use file containing surgical cases submitted by 173 hospitals throughout the United States were analyzed for the calendar years 2005 to 2007. Dedicated nurse clinical reviewers at each hospital prospectively enrolled patients and collected data in a standardized fashion according to strict ACS NSQIP definitions. The systematic sample was obtained by taking the first 40 cases per nurse reviewer on an 8-day cycle from the operating room log, ensuring that no particular operating room day block time would bias the weighting of cases. Nurse reviewers received training regarding definitions and data extraction, had continuing education and monitoring through the ACS-NSQIP program, and were assessed for inter-rater reliability during biennial site visits. Information was obtained from computerized and/or paper patient medical records, physician office records, and telephone interviews with patients. Patients are followed after hospital discharge up to 30 days postoperatively. The accuracy and reproducibility of the data have been previously demonstrated.⁸

The database was queried for patients undergoing EVAR as identified by the primary procedure CPT codes for aortic tube prosthesis (CPT 34800), modular bifurcated prosthesis - one docking limb (CPT 34802), modular bifurcated prosthesis - two docking limbs (CPT 34803), unibody bifurcated prosthesis (CPT 34804), and aorto-uniliac or unifemoral prosthesis (CPT 34805). Patients were further classified as to whether they had had an iliac or brachial exposure (CPT 34820, 34833 or 34834), secondary femoral-femoral crossover (CPT 34813), coil embolism (CPT 37204), and/or single or multiple extension cuff(s) (CPT 34825 or 37204) during EVAR.

Data were analyzed on 55-patient preoperative risk factors, eight procedure and intraoperative variables, and 30-day outcomes. The outcomes examined were mortality, any morbidity as defined by the occurrence of one or more of 21 postoperative adverse events uniformly defined by the ACS NSQIP, and length of hospital stay. Adverse events were further classified into subgroups including infectious, wound, pulmonary, renal, transfusion, and graft failure. According to the ACS NSQIP manual, graft failure was defined as, "mechanical failure of an extra-cardiac graft or

prosthesis . . . requiring return to the operating room, interventional radiology, or a balloon angioplasty." Infectious complications included superficial, deep, or organ/space surgical site infection, pneumonia, sepsis, septic shock, and/or urinary tract infection. Wound complications included superficial, deep, or organ/space surgical site infection and/or wound dehiscence. Pulmonary complications included pneumonia, unplanned intubation and/or ventilation >48 hours postoperatively. Postoperative transfusion was recorded as an adverse event if the patient received >4 units of packed red blood cells within 72 hours of surgery.

Statistical analysis. Patients were grouped by gender and bivariate differences in preoperative risk factors, procedure variables, and outcomes were analyzed using χ^2 (binary or categorical variables) and *t* tests (continuous variables). The relationship of gender with mortality, morbidity, and each of the six complication subgroups was further evaluated using multivariate logistic regressions to adjust for risk and procedure variables. For each model, all ACS NSQIP preoperative risk variables were considered, but only those independently predictive of the outcome were included in a forward stepwise fashion ($P \leq .05$ for entry, $P \geq .10$ for exit). Procedure variables were then added in a similar forward stepwise manner and lastly gender was forced into the final model. Calibration of the logistic regression models was calculated using the c-index and Hosmer-Lemeshow (H-L) statistic. Length of stay was similarly analyzed using multivariate linear regression.

RESULTS

From the database, 3662 patients were identified who underwent EVAR including: tube grafts (360, 9.8%); bifurcated, one docking limb (1624, 44.3%); bifurcated, two docking limbs (1294, 35.3%); unibody (218, 5.9%); and aorto-uni-iliac/femoral (166, 4.4%) repair. The use of tube grafts and aorto-uni iliac/femoral repairs was associated with a higher percentage of emergent operations, greater 30-day morbidity and mortality, and longer hospital stays (Table I, all χ^2 or analysis of variance [ANOVA] $P < .001$).

EVAR patients included 647 (17.7%) women and 3015 (82.3%) men with mean ages of 75.1 ± 9.0 years and 73.7 ± 8.5 years respectively ($P < .001$). Numerous gender differences in preoperative risk variables were identified. (See Appendix, Table AI, online only, for complete list of ACS NSQIP risk variables and occurrence rates by gender.) Risk variables that were found by forward stepwise regression analysis to be predictive of EVAR mortality or morbidity are shown in Table II with occurrence rates by gender. Of these, women were more likely to undergo emergent surgery, be functionally dependent, have recent weight loss, be underweight or morbidly obese, and/or have severe chronic obstructive pulmonary disease. Men were more likely to have elevated creatinine levels. Intraoperatively, women were more likely to have EVAR using a tube or aorto-uni-iliac/femoral graft that demonstrated higher

Table I. Patient count by type EVAR

Type of repair	CPT code	No of patients (% of total)	Emergent %	30-day morbidity %	30-day mortality %	Hospital stay (days \pm SD)
Aortic						
Tube graft	34800	360 (9.8)	11.1	18.1	5.0	5.7 \pm 8.5
One docking limb	34802	1624 (44.3)	3.9	10.0	1.8	3.5 \pm 6.4
Bifurcated, two docking limbs	34803	1294 (35.3)	3.2	11.2	1.3	3.7 \pm 6.1
Unibody	34804	218 (5.9)	2.8	10.1	1.8	3.5 \pm 5.7
Aorto-uni-iliac/femoral	34805	166 (4.5)	12.7	24.7	6.0	6.1 \pm 8.0
Total		3662	4.7	11.9	2.1	3.9 \pm 6.6

EVAR, Endovascular aneurysm repair.

Emergent status, morbidity, mortality, and hospital stay varied significantly by type of EVAR (χ^2 or ANOVA $P < .001$, $N = 3662$).**Table II.** EVAR preoperative patient characteristics by gender

Characteristic	Women	Men	P value
No. of patients	647 (17.7%)	3015 (82.3%)	
Age (mean years \pm SD)	75.1 \pm 9.0	73.7 \pm 8.5	<.001*
Emergent procedure	6.5%	4.3%	.020*
ASA physical status class 4 or 5	22.3%	20.1%	.225
Preoperative systemic infection			.556
SIRS	3.1%	2.2%	
Sepsis	.3%	.2%	
Septic shock	.3%	.4%	
Functional dependence			.001*
Partial	6.5%	4.0%	
Full	2.6%	1.3%	
On dialysis	1.9%	1.2%	.180
Recent weight loss >10%	3.2%	1.8%	.015*
Disseminated cancer	.8%	.9%	.761
Medically treated hypertension	80.7%	77.9%	.125
Blood urea nitrogen >40 mg/dL	4.5%	3.7%	.380
Serum creatinine >1.2 mg/dL	21.8%	34.2%	<.001*
Body mass index obesity class			<.001*
Underweight (BMI < 18.5)	5.3%	2.0%	
Morbidly obese (BMI > 40)	3.0%	2.2%	
Medically treated diabetes			.058
Oral	9.4%	11.9%	
Insulin	1.7%	2.7%	
History of severe COPD	23.3%	18.2%	.003*

SIRS, Systemic inflammatory response syndrome; COPD, chronic obstructive pulmonary disease; ASA, American Society of Anesthesiologists; BMI, body mass index; EVAR, endovascular aneurysm repair.

Characteristics shown are independent predictors of either mortality or morbidity in EVAR patients (except age).

P value is for χ^2 (categorical and binary variables) or t test (age) of gender differences. $N = 3662$.*Highlights P values <0.05.

morbidity and mortality. They required significantly more iliac or brachial exposures, more femoral-femoral cross-overs, more frequent blood transfusion, and significantly longer operative times (Table III).

Table III. Intraoperative characteristics by gender

Procedure/intraoperative variable	Women	Men	P value
No. of patients	647 (17.7%)	3015 (82.3%)	
Type of graft/procedure			<.001*
Tube graft	14.1%	8.9%	
Bifurcated, one docking limb	43.6%	44.5%	
Bifurcated, two docking limbs	30.3%	36.4%	
Unibody	4.8%	6.2%	
Aorto-uni-iliac/femoral	7.3%	3.9%	
Adjunct procedure(s)			
Iliac or brachial exposure	2.8%	1.0%	.009*
Femoral-femoral crossover	3.9%	1.8%	.011*
One or more extension cuffs	25.7%	28.5%	.137
Coil embolism	2.2%	3.2%	.132
Operative duration (minutes \pm SD)	182 \pm 88.6	162 \pm 73.7	<.001*
Transfused intraoperatively	25.3%	12.7%	<.001*
Packed red blood cells (mean units \pm SD of those transfused)	3.3 \pm 3.3	3.1 \pm 3.6	.516

P value is for χ^2 (categorical and binary variables) or t test (continuous variables) of differences across gender. $N = 3662$.*Highlights P values <0.05.

Overall 30-day mortality was 2.1% and was higher in women (3.4% vs 2.1%; $P = .014$, Table IV). Eight independent preoperative risk factors for mortality were identified by multivariate regression. They were by order of entry: (1) ASA class, (2) systemic infection, (3) emergent surgery, (4) recent weight loss, (5) currently on dialysis, (6) disseminated cancer, (7) functional dependence, and (8) medically treated hypertension. (Rates by gender are reported in Table II, independent odds ratios are reported in the Appendix, Table AII, online only.) Use of iliac or brachial exposure was a significant operative risk variable. After adjustment for these variables, the odds ratio for mortality in women vs men was 1.52 (95% CI 0.85-2.69, $P = .157$). The c-index for the mortality model was 0.85 and the H-L statistic P value was .315.

Table IV. Outcomes by gender: unadjusted and adjusted for significant risk factors and procedure variables. Bivariate *p*-value is for χ^2 test except for *t* test of hospital stay

30-day outcome	All N = 3662	Female N = 647	Male N = 3015	Bivariate P value	Multivariate ^a odds ratio Female vs male (95% CI)	Multivariate P value
Mortality	2.1%	3.4%	1.9%	.014	1.52 (0.85-2.69)	.157
Overall morbidity ^c	11.9%	17.8%	10.6%	<.001	1.65 (1.28-2.14)	<.001
Length of hospital stay, mean days \pm SD	3.9 \pm 6.6	5.1 \pm 6.7	3.7 \pm 6.6	<.001	+0.7 ^b (0.2-1.2)	.008
Infectious complication ^d	7.3%	11.1%	6.5%	<.001	1.49 (1.10-2.03)	.011
Wound occurrence ^c	2.5%	4.3%	2.2%	<.001	1.80 (1.12-2.90)	.015
Pulmonary complication ^f	4.4%	6.5%	4.0%	<.001	1.41 (0.93-2.13)	.106
Renal insufficiency or failure	2.3%	2.8%	2.2%	<.001	1.33 (0.74-2.38)	.344
Postop transfusion >4 u. w/in 72 h of procedure	1.0%	2.3%	0.7%	<.001	2.92 (1.39-6.13)	.005
Graft/prosthesis failure ^g	1.4%	2.3%	1.2%	<.001	1.72 (0.92-3.22)	.088

Bivariate *P* value is for χ^2 test except for *t* test of hospital stay.

^aOutcome model Hosmer-Lemeshow statistic *P* values, c indices, and independent predictors are listed in [appendix Table A1](#).

^bMultivariate result for length of hospital stay is the linear regression beta coefficient in days.

^cComposite morbidity was one or more of 21 adverse events uniformly defined by the ACS NSQIP.

^dInfectious complications included deep, superficial, or organ/space surgical site infection, pneumonia, sepsis or septic shock, and/or urinary tract infection.

^eWound occurrence included deep, superficial, or organ/space surgical site infection, and/or wound dehiscence.

^fPulmonary complication included ventilation > 48 h, unplanned intubation, and/or pneumonia.

^gGraft/prosthesis failure was defined as, "mechanical failure of an extracardiac graft or prosthesis . . . requiring return to the operating room, interventional radiology, or a balloon angioplasty."

Overall morbidity was 11.9% and was higher in women (17.8% vs 10.6%; $P < .001$, [Table IV](#)). Likewise, the incidence of adverse events in each of the six complication subgroups as well as length of stay was significantly higher in women ($P < .001$, [Table III](#)). Eight independent preoperative predictors of morbidity were by order of entry: (1) emergent surgery, (2) functional dependence, (3) systemic infection, (4) elevated blood urea nitrogen, (5) elevated serum creatinine, (6) body mass index obesity class, (7) medically treated diabetes, and (8) severe chronic obstructive pulmonary disease [COPD]. (Rates by gender are reported in [Table II](#), independent odds ratios are reported in the [Appendix, Table AII, online only](#)) As mentioned for mortality, women had significantly higher incidence of emergent surgery and functional dependence. They also were more frequently underweight or morbidly obese. Elevated serum creatinine was higher in men. Independent procedure variables predictive of morbidity were primary repair type, iliac or brachial exposure, and femoral-femoral crossover: women had significantly greater risk in all three. After adjustment for these preoperative and procedure risk variables, the odds ratio for morbidity in women was 1.65 (95% CI 1.28-2.14, $P < .001$). After similar adjustment, female gender remained significantly predictive of length of hospital stay (Beta +0.7d, 95% CI 0.2-1.2d, $P = .008$), infectious complications (O.R. 1.49, 95% CI 1.10-2.03, $P = .011$), wound occurrences (O.R. 1.80, 95% CI 1.12-2.90, $P = .015$), and postoperative transfusion (O.R. 2.92, 95% CI 1.39-6.13, $P = .005$) ([Table IV](#)). The specific adjustment variables for the complication subgroup multivariate logistic regression models are listed in the [Appendix](#). The model c-indices ranged from 0.64 for graft failure to 0.85 for postoperative transfusion and all H-L statistic *P* values were greater than .05.

DISCUSSION

The current study, in a large contemporary, multi-center population demonstrates that the 30-day mortality and morbidity in patients undergoing EVAR is higher in women than men. Multivariate analysis indicated that the increased risk of mortality could be accounted for by more emergent operations, physical debilitation (recent weight loss and functional dependence), and greater need for iliac or brachial exposure in women. From the data set, we cannot determine how many emergent operations were related to ruptured AAA, but it is well known that AAA repair done under emergent conditions is associated with a higher mortality.⁹ It may be that AAA in women, being more common in men, is not diagnosed until symptomatic, resulting in the need for more frequent emergent intervention. Concerning dependent functional status, the 2007 ACS NSQIP national risk modeling placed functional status the first of 31 independent predictors of 30-day mortality in vascular surgery patients¹⁰, but it remains unclear why women undergoing EVAR have a higher incidence.

As opposed to mortality, multivariate analysis demonstrated that gender was independently associated with a higher risk for development of one or more postoperative complications after adjustment for available ACS NSQIP risk and operative factors. Specifically, women had independent increased risk for infectious complications, wound occurrences, and need for transfusion as well as longer length of stay. In addition to the mortality risk factors mentioned above, women had higher incidence of morbid obesity and severe COPD, independent predictors of overall morbidity. Again, we are unable to determine why women treated with EVAR had higher incidence of these risk factors.

Operative variables more prevalent in women (brachial and iliac exposure, femoral-femoral cross over graft, and type of EVAR procedure) were associated with higher morbidity and mortality. We hypothesize that women have more challenging anatomy, factors not available in the ACS NSQIP data set. Such factors could include neck angulation, size of the neck, small iliac diameter, associated occlusive disease, and tortuosity of the iliac arteries; and conditions that would affect the procedure. Challenging vascular anatomy could also contribute to longer operative duration and increased need for transfusion as observed in women observed in this study. Buth et al reported that the female gender and a patient age greater than 75 were significant risk factors for the incidence of endoleak and suggested that increased age may be associated with more complex aortic anatomy.¹¹ Others have commented on the fact that women tend to have smaller vessels and a higher need for adjunct procedures to gain access for EVAR deployment.^{12,13}

These findings lead to questions that should be addressed in future studies. It would be important to include anatomic details such as size of the aneurysm, details concerning the aortic neck, and specifics regarding the access vessels in men compared with women. This information would help determine if the difficult aortic anatomy in women is related to choice of operation, length of procedure, and transfusion requirement. It would also be critical to evaluate why women have a higher incidence of emergent EVAR and why women are more likely to present more physically debilitated than men. Such information could impact AAA surveillance protocols, especially as they relate to women. Since the ACS NSQIP database provides only 30-day follow-up, long-term outcome and durability cannot be determined. It would be important to determine if early outcomes parallel long-term results. Since the data used in the study was pooled from many institutions, future studies might also focus on the volume of individual institutions and/or surgeons and the contribution of patients from private or academic institutions.

There are significant benefits of the current study. This study demonstrates outcomes for EVAR prospectively and systematically sampled from a broad range of academic and private hospitals. As such, the data represents an accurate picture of current 30-day outcomes for patients treated with endografts in the United States. The ratio of women to men (1:4.66) and overall mortality rate in our study (2.1%) compares favorably with those reported by others.¹¹ The robust clinical risk variables, as tabulated in the ACS NSQIP data set, provides novel observations regarding the physical and emergent status of women presenting for EVAR as well as operative differences.

In summary, we have demonstrated that women undergoing EVAR have an increased mortality and morbidity. The mortality risk in women is associated with emergent status, physical condition, and procedure variables. Despite adjustment for multiple preoperative and operative factors, women remained at significantly higher risk for the devel-

opment of a broad range of complications. While the reasons for this risk cannot be definitively identified from data obtained in the current study, we hypothesize that at least one factor contributing to this finding may be more challenging aortic anatomy in women. Until further studies identify why women present more emergently and in a more debilitated state, appropriate patient selection, management of comorbid conditions, and attention to anatomic factors that make EVAR more difficult may result in improved outcomes for women undergoing EVAR.

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

AUTHOR CONTRIBUTIONS

Conception and design: EE, NA, DM
Analysis and interpretation: EE, NA, DD
Data collection: NA, DD
Writing the article: EE, NA, DD
Critical revision of the article: ES, EX
Final approval of the article: EE
Statistical analysis: DD
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NA and DD contributed equally to this work.

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APPENDIX, online only.

Table AI, online only. Prevalence of ACS NSQIP risk factors by gender

<i>Risk factor</i>	<i>Female n = 647</i>	<i>Male n = 3015</i>	<i>P value</i>
Age in years with patients over 89 coded as 90 (mean \pm SD)	75.1 \pm 9.0	73.7 \pm 8.5	<.001
Race			.004
Native American	.3%	.1%	
Asian	.8%	1.3%	
African American	6.5%	3.4%	
Hispanic	2.0%	1.8%	
Unknown	8.5%	8.9%	
White	81.9%	84.6%	
Emergency case	6.5%	4.3%	.020
ASA physical status classification			.460
1	.3%	.1%	
2	7.6%	7.2%	
3	69.8%	72.6%	
4	21.2%	19.1%	
5	1.1%	1.0%	
Pack-years of smoking	35.14	42.71	<.001
Current smoker within one year	35.4%	28.1%	<.001
EtOH > 2 drinks/day in 2 wks before admission	1.1%	4.6%	<.001
Do not resuscitate (DNR) status	1.1%	.4%	.018
Ventilator dependent	1.4%	.3%	<.001
History of severe COPD	23.3%	18.2%	.003
Current pneumonia	.9%	.3%	.013
Ascites	.5%	.4%	.812
Esophageal varices	.0%	.1%	.512
Hypertension requiring medication	80.7%	77.9%	.125
Hx of CHF, angina, or AMI	4.3%	5.0%	.466
Prior cardiac operation or PCI	27.4%	41.2%	<.001
History of revasc./amput. for periph. vascular disease	7.1%	6.1%	.355
Rest pain/gangrene	1.5%	0.9%	.160
Acute renal failure	.3%	.4%	.659
Currently on dialysis	1.9%	1.2%	.180
History of stroke/CVA/TIA/hemiplegia	15.0%	15.2%	.882
Impaired sensorium	1.1%	.6%	.138
Coma > 24 hours	.3%	.1%	.190
Tumor involving central nervous system	.0%	.1%	.422
Open wound/wound infection	2.3%	1.1%	.017
Steroid use for chronic condition	5.6%	4.3%	.153
Loss of > 10% body weight in last 6 months	3.2%	1.8%	.015
Disseminated cancer	.8%	.9%	.761
Chemotherapy for malignancy in \leq 30 days preop	.3%	.3%	.847
Radiotherapy for malignancy in last 90 days	.5%	.4%	.909
Bleeding disorder	1.7%	11.2%	.706
Transfusion > 4 units PRBCs in 72 hours before surgery	.6%	.1%	.016
Serum albumin g/dL, mean \pm SD	3.79 \pm 0.66	3.87 \pm 0.55	.023
International normalized ratio of prothrombin time, mean \pm SD	1.12 \pm 0.34	1.11 \pm 0.33	.612
Alkaline phosphatase > 125 U/L	5.4%	4.0%	.120
Sodium < 135 mmol/L	9.0%	5.8%	.003
Sodium > 145 mmol/L	.8%	1.5%	.152
BUN > 40 mg/dL	4.5%	3.7%	.380
Creatinine > 1.2 mg/dL	21.8%	34.2%	<.001
Bilirubin > 1.0 mg/dL	3.2%	5.7%	.011
Serum glutamic oxaloacetic transaminase > 40 U/L	3.4%	3.1%	.676
White blood cell count \leq 4500/cumm	5.6%	4.4%	.205
White blood cell count > 11000/cumm	5.9%	6.6%	.495
Hematocrit < 38%	44.7%	25.9%	<.001
Hematocrit > 45%	6.3%	16.5%	<.001
Platelet count < 150,000/cumm	8.5%	13.1%	.001
Platelet count > 400,000/cumm	4.0%	2.3%	.014
Partial thromboplastin time > 35 s	7.9%	8.3%	.711
Prothrombin time > 13.2 s	3.3%	32.8%	.216

Table AI, online only. Continued

<i>Risk factor</i>	<i>Female n = 647</i>	<i>Male n = 3015</i>	<i>P value</i>
Body mass index (BMI) obesity category kg/m ²			<.001
≤18.5	5.3%	2.0%	
18.5 < BMI ≤ 25	36.7%	26.4%	
25 < BMI ≤ 30	32.3%	40.5%	
30 < BMI ≤ 35	16.3%	21.9%	
35 < BMI ≤ 40	6.4%	7.0%	
> 40	3.0%	2.2%	
Medically treated diabetes			.058
None	88.9%	85.4%	
Orally treated	9.4%	11.9%	
Insulin treated	1.7%	2.7%	
Dyspnea			.010
None	72.5%	76.2%	
After mild exertion	23.6%	21.8%	
At rest	3.9%	2.1%	
Functional dependence			.001
None	90.9%	94.6%	
Partial	6.5%	4.0%	
Full	2.6%	1.3%	
Preoperative systemic infection			.556
None	96.3%	97.2%	
SIRS	3.1%	2.2%	
Sepsis	.3%	.2%	
Septic shock	.3%	.4%	

P value is for χ^2 (categorical and binary variables) or *t* test (continuous variables) of differences across gender. N = 3662.

AMI, Acute myocardial infarction; ASA, American Society of Anesthesiologists; BUN, blood urea nitrogen; COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure; CVA, cerebral vascular accident; PCI, percutaneous coronary intervention; TIA, transient ischemic attack.

Table AII, online only. Outcome regression models using ACS NSQIP data for endoluminal repaired abdominal aortic aneurysm patients: model H-L statistic *P* values, c indices, and independent risk variable odds ratios from forward stepwise regression (*P* for entry < .05, for exit > 0.10), N = 3660

<i>Model (% occurrence)</i>	<i>Mortality (2.1%)</i>	<i>Composite morbidity^a (11.9%)</i>	<i>Infectious complic.^b (7.3%)</i>	<i>Wound occurrence^c (2.5%)</i>	<i>Pulmonary complic.^d (4.4%)</i>	<i>Renal insufficiency or failure (2.3%)</i>	<i>Postop transfusion > 4u. w/in 72 h of procedure (1.0%)</i>	<i>Graft/ prosthesis failure^e (1.4%)</i>
Hosmer-Lemeshow Statistic <i>P</i> value	.315	.161	.529	.131	.889	.635	.724	.931
C index	0.85	0.70	0.69	0.72	0.81	0.83	0.85	0.64
<i>Independent procedure and risk variable odds ratios in each model; * <i>P</i> < .10 in final model; "—" indicates variable was not in model.</i>								
Female vs male	1.52	1.65*	1.49*	1.80*	1.41	1.33	2.92*	1.72*
Iliac or brachial exposure	3.39*	1.85*	—	—	3.31*	—	—	—
Femoral/femoral crossover	—	1.85*	2.19*	4.29*	2.62*	2.09*	—	—
Primary CPT vs 34800								
34802	—	0.65*	—	—	0.40*	0.54*	0.34*	—
34803	—	0.79	—	—	0.55*	0.52*	0.25*	—
34804	—	0.65	—	—	0.67	0.40	0.24	—
34805	—	1.10	—	—	0.63	0.93	0.55	—
Coil embolism	—	—	—	—	2.94*	—	—	—
Preop systemic inf. vs none								
SIRS	2.04*	3.49*	3.39*	—	3.41*	3.15*	3.31*	—
Sepsis	8.58*	4.91*	5.86*	—	3.03	0.40	9.00*	—
Septic Shock	9.10*	0.93	1.16	—	0.64	2.81	0.00	—
ASA Class vs 1-3								
ASA 4	2.87*	—	—	—	1.94*	—	—	—
ASA 5	8.80*	—	—	—	2.43*	—	—	—
Emergent surgery	4.24*	3.07*	2.81*	—	4.26*	4.50*	3.08*	—
On dialysis	4.53*	—	3.29*	5.26*	—	0.12*	—	—
Recent weight loss > 10%	3.56*	—	—	—	—	—	3.40*	—
Disseminated cancer	4.77*	—	—	—	—	—	—	—
Functional status vs independent								
Partially dependent	1.27	1.79*	2.04*	—	1.53	1.67	2.45*	—
Fully dependent	3.61*	3.41*	2.68*	—	3.02*	2.15*	6.96*	—
Treated hypertension	2.41*	—	—	0.57*	—	—	—	—
BUN > 40	—	1.71*	—	—	—	2.98*	—	—
Creatinine > 1.2	—	1.51*	—	—	1.66*	2.18*	—	—
BMI vs 18.5-25								
BMI < 18.5	—	1.72*	2.52*	1.04	3.37*	—	—	2.71*
25 < BMI ≤ 30	—	0.86	1.11	1.17	0.95	—	—	0.68
30 < BMI ≤ 35	—	1.03	1.47*	2.44*	0.89	—	—	0.45*
35 < BMI ≤ 40	—	1.02	1.26	2.10	1.50	—	—	0.46
BMI > 40	—	2.14*	4.26*	8.99*	1.14	—	—	0.64
Diabetes vs none								
Orally treated	—	1.35*	—	—	—	—	—	—
Insulin treated	—	1.83*	—	—	—	—	—	—
COPD	—	1.31*	—	—	—	—	2.28*	—
Esophageal varices	—	—	21.14*	—	32.59*	—	—	—
Hematocrit < 38%	—	—	1.33*	1.76*	—	—	—	—
CNS tumor	—	—	11.21*	—	—	—	—	—
Bleeding disorder	—	—	—	1.94*	—	—	—	—
Smoker	—	—	—	1.64*	—	—	0.13*	—
DNR status	—	—	—	—	4.94*	—	—	—
Sodium < 135	—	—	—	—	0.42*	—	—	—
Serum albumin	—	—	—	—	—	0.42*	—	—
On steroids for chronic condition	—	—	—	—	—	3.27*	—	—
AlkPhos > 125	—	—	—	—	—	0.09*	—	—
Preop renal failure	—	—	—	—	—	4.04*	—	—

Table AII, online only. Continued

<i>Model (% occurrence)</i>	<i>Mortality (2.1%)</i>	<i>Composite morbidity^a (11.9%)</i>	<i>Infectious complic.^b (7.3%)</i>	<i>Wound occurrence^c (2.5%)</i>	<i>Pulmonary complic.^d (4.4%)</i>	<i>Renal insufficiency or failure (2.3%)</i>	<i>Postop transfusion >4u. w/in 72 h of procedure (1.0%)</i>	<i>Graft/ prosthesis failure^e (1.4%)</i>
Recent radiotherapy	—	—	—	—	—	—	8.16*	—
Rest pain/gangrene	—	—	—	—	—	—	—	6.41*

Each model included all ACS NSQIP variables independently predictive of the outcome through forward stepwise regression, then the procedure variables included through forward stepwise regression, then gender forced as the last independent variable.

ASA, American Society of Anesthesiologists; BMI, body mass index; BUN, blood urea nitrogen; COPD, chronic obstructive pulmonary disease; CNS, central nervous system; DNR, do not resuscitate; SIRS, systemic inflammatory response syndrome.

^aComposite morbidity was one or more of 21 adverse events uniformly defined by the ACS NSQIP.

^bInfectious complications included deep, superficial or organ/space surgical site infection, pneumonia, sepsis or septic shock, and/or urinary tract infection.

^cWound occurrence included deep, superficial or organ/space surgical site infection, and/or wound dehiscence.

^dPulmonary complication included ventilation >48 h unplanned intubation and/or postoperative pneumonia.

^eGraft/prosthesis failure was defined as, “mechanical failure of an extracardiac graft or prosthesis . . . requiring return to the operating room, interventional radiology, or a balloon angioplasty.”

*Highlights *P* values <0.05.